External debt and military spending: the case of Africa's conflict countries

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ABSTRACT

In the light of the exigency and apparent irrationality of war and, the fact that most Heavily Indebted Poor Countries (HIPCs) in Africa are associated with prolonged conflicts, there is more than a suspicion that military spending contributes to the indebtedness of Africa's conflict countries. We therefore model this suspected nexus and compute the impulse response functions to the shock in military spending and, particularly determine what precise time around war external debt accumulation is prevalent. We confirm a positive correlation between military spending and external debt for most of the conflict countries, with external debt increasing in response to a shock to military spending for all these countries. Using panel analysis, we find evidence of military expenditure's upward pressure on external indebtedness during pre-war, war and post-war periods; interestingly, the post-war period registers the fastest rate of external debt accumulation than other relevant periods. Our results suggest that military spending can be an important and nuanced factor in designing external debt management policies for Africa's conflict countries and their likes.

Key words: External debt, Military spending, DSGE model, Conflict countries, Relevant war periods

1 Introduction

The literature on military spending mainly focuses on military spending effects on economic growth, starting from the seminal works of Benoit (1973, 1978). Few studies focus on the relationship between military spending and external debt. Upon examining this nexus, Brzoska (1983) found that military expenditure is an important component of external debt for many developing countries. Looney and Frederiksen (1986) posit that defence expenditures have a direct effect on a country's external debt stock if the country is an arms importer that finances its imports by using external funds. Alternatively, if a country's imports are financed by export earnings, resources that could have been put to better alternative uses are squandered on debt servicing instead; in other words, the effect here is indirect. This postulation is supported by Alami's (2002) two interrelated but distinct channels that trace the debt-creating effects of military outlays – i.e., government balances and import bills, in his study of the relation between "military debts"[1] and external debts of Arab countries. Military commitments can contribute to increased internal deficits or create budgeting problems by displacing or affecting public spending on other items. This may, in turn, force a government to finance the resulting civilian commitment through external borrowing.

Dunne et al (2004a) conducted a panel analysis, using a sample of small industrialising countries, to determine the economic effect of military spending on debt. They find that military expenditure has a positive impact on the share of external debt in GDP. Further, Dunne et al (2004b) evaluated the impact of military spending on the external debt of three South American countries: Argentina, Brazil and Chile. They found that military spending burden tended to increase debt in Chile but show no effect on the evolution of debt in Argentina and Brazil. Narayan and Smyth (2009) also document similar results upon using a panel of six Middle Eastern countries to examine the same nexus.

[1] Alami (2002) defines military debt as credits and loans specifically earmarked for military purposes.

Günlük-Senesen (2004a) focused on the relation between macroeconomic imbalances and defence expenditures. He argues that for countries where defence spending is regarded as inevitable, government budgets are planned accordingly, hence defence spending increases budget deficits. Since governments are usually reluctant or unable to raise additional tax income or reduce welfare expenditures, increased government debts lead to external indebtedness. In another study, Günlük-Senesen (2004b) argues there are three channels through which defence spending promotes external borrowing. First, defence burdens the total budget and, thus increases government borrowing requirements, which in turn is met either through domestic and/or foreign sources. Second, if a country is an arms importer and foreign exchange revenue falls short of the total import bill, then foreign borrowing is a most likely source of foreign exchange. Third, demand for foreign exchange may also be induced by indigenous arms production, a typical outcome in developing countries, where the foreign exchange is needed to import foreign inputs.

For a set of starkly contrasting findings, Sezgin (2005), upon applying Engle-Granger methodology, finds that Turkey's external debt is negatively affected by its military expenditure. Karagol (2005) also runs Granger causality test between external debt and defence expenditures for Turkey for the period 1979-2000 and, finds that there is a unidirectional short-run causal relation running from defence expenditures to external debt. A nuanced result emanates from a follow-up study by Karagol (2006) when he investigates the relation between external debt, defence expenditures and gross national product in Turkey; he finds that financing defence expenditures through internal and external indebtedness crowds out the private sector from profitable investment opportunities. This negatively affects economic growth via the investment channel. Karagol's impulse response functions show a positive response of external debt to a positive shock to defence spending.

Specifically, Wolde-Rufael (2009) finds that an increase of 1% in defence spending increases the stock of external debt by 1.5% in Ethiopia. Their result corroborates the finding by Narayan and Narayan (2008) for Fiji. Yet in a more recent causality test by Georgantopoulos and Tsamis (2011) for four emerging Northern Africa countries – i.e., Egypt, Tunisia, Algeria and Morocco; these authors

find no causal link between military expenditure and external debt for Algeria, Tunisia and Morocco, but record a unidirectional causality running from defence expenditures to external debt for Egypt. They conclude that this latter finding suggests defence spending can be used as a useful macroeconomic tool for adjusting external debt in Egypt.

From the foregoing, there are several salient issues pointing to the need for further research in this area and how such research should be nuanced to provide less conflicting outcome. One, there are mixed results on the contribution of military spending to the indebtedness of countries, most are positive while others are either negative or have no effect. Two, the extant studies are largely empirical in nature, with very few modelling the economics that underline the suspected spending-debt nexus. Three and importantly, there are no cross-country (with only one country-specific) studies that look at military spending-external debt nexus for Sub-Saharan African countries, many of which had been burdened spectacularly by external indebtedness. This study aims to fill the last two gaps by focusing on African countries that have at least experienced an episode of civil conflict.

More specifically, our study differs from previous studies in four distinct ways. First, it explores the effect of military spending on external debt for African countries that have had episodes of civil strife. The assumption is that during the periods of civil strife, countries increase their purchase of military equipment; thus, this specific episode which is usually commonplace in the developing world bears investigation. The only study that has covered African countries, to our knowledge, is Looney (1990) who looked at military expenditures and economic performance of conflict and non-conflict countries. Second, our study is nuanced in a way that yields policy guide as to how best to mitigate the inevitable lingering costs of conflict, of which external indebtedness can be the most persistent if not effectively managed. The innovation here is that we determine the specific time period in which Africa's conflict countries accumulate external debt the most; and if this time period is one that is amenable to relative control, then prevention would certainly be better than cure in terms of the indebtedness problem.

Third, Looney used a panel data to estimate a simple empirical model. Our study differs from Looney's study in the sense that we develop a DSGE model for the economy. In our model, we include military spending in the utility function, in line with Gong and Zou (2003) and, we also add military spending in the debt function. Our intuition is that military spending contributes to the external indebtedness of countries, particularly countries in conflict. By explicitly modelling this pertinent nexus, we are able to determine as well as trace the channels of the impact of military spending on macroeconomic variables, including external debt.

Finally, we simulate the model in order to gauge the response of external debt and other macroeconomic variables to a shock in military spending. In computing the impulse response functions, we use Uhlig's (1999) method of undetermined coefficients. This is an improvement on Karagol's (2006) methodology where VAR was used to compute impulse response functions. To mention briefly, we find that military spending has a positive impact on the indebtedness of Africa's conflict countries. Interestingly, military spending leads to a significant increase in external debt during all phases of the conflict – i.e., pre-war, war and post-war periods – with the most debt accumulation occurring during the post-conflict period.

In the next section we highlight the cursory relationship between military spending and external debt for Africa's conflict countries. In section 3 we develop the DSGE model and, we estimate the model in section 4. In section 5 we simulate the effect of a positive shock to military spending on the macro-economy. Section 6 assesses the period in which military spending contributes to external debt most markedly, and section 7 concludes the paper.

2. Military Spending and External Debt

The cause of indebtedness of African countries has been a major issue of debate since the debt crisis of 1980 (for historical accounts, see Easterly, 2002; Muhanji and Ojah, 2011a&b among others). Most of these countries have weak economic structures that have led to aid dependency when financing budget deficits. However, the role of military spending in understanding the indebtedness of

conflict countries in Africa has received little attention. Though the percentage of military spending to GDP may seem small, the exigency that underline this kind of expenditure appears highly likely to contribute to the indebtedness of a country especially if the country runs a budget deficit and is forced to resort to foreign borrowing to finance its budget. The cursory relationship between external debt and military spending for select African conflict countries is shown in Figure 1.

Insert Figure 1 Here

Figure 1 shows that military spending and external debt move in the same direction in Burundi, Uganda, Djibouti, Eritrea, Mali and Mozambique. This implies that as countries increase their military expenditure, external debt increases or vice-versa. For a country like Angola, external debt exhibits a lagged response to changes in military spending. Burkina Faso, Ethiopia and Sudan exhibit a less than clear pattern of association between these variables. Yet the upshot of Figure 1 is that there is ample cursory evidence of correlation between military spending and external debt.

3. The Model

We develop a dynamic stochastic general equilibrium (DSGE) model of military spending and external debt for a typical African country. The model is derived from first principles and describes a model economy in which agents (households, firms and/or government, financial intermediaries, etc) dynamically maximize their objectives (utility/profit) subject to their budget and resource constraints.

3.1 Household's Behavior

The representative economy is populated by identical households. Households consume military goods as part of their overall consumption. The representative household's intertemporal utility function is given by:

$$Max \int_0^{\infty} U\left(C, M^l, C_{m_t}\right) e^{-\beta_t} d_t \qquad (1)$$

Where β is the discount factor. The utility function has three augments – domestic consumption C, consumption imports C_{m_t}, and military expenditure M^l , over an infinite life horizon. Domestic consumption, consumption imports and military expenditure are positively related to utility. We follow Gong and Zou (2003) in assuming that military spending is positively related to utility by way of its impact on security.

The instantaneous utility function is concave and twice differentiable. It is also separable in the consumption of domestic goods, merchandise imports and military spending. The utility function takes the following form:

$$U\left(C, C_m, M^l\right) = \frac{1}{1-\sigma} {C_t}^{1-\sigma} + \frac{1}{1-\theta} {C_{m_t}}^{1-\theta} + e^{\xi_{m_t^l}} \frac{1}{1-\omega} {M_t^l}^{1-\omega}, \quad (2)$$

Where σ is the inverse of the intertemporal elasticity of substitution, θ is inverse of the elasticity of consumption imports, ω is the inverse of the elasticity of military spending and $\xi_{m_t^l}$ is the preference shock to military spending. Military spending shock is exogenously determined and follows an AR(1) process of the form $\xi_{m_t^l} = \rho_{m^l} \xi_{m_{t-1}^l} + \xi_{m^{l*}}$.

Household's capital stock is a function of the lagged capital stock and investment. It takes the form:

$$K_t = (1-\delta)K_{t-1} + S(I_t^m / I_{t-1}^m) I_t^m \quad (3)$$

Where δ is the depreciation rate; I_t^m is imported investments; K_t is the capital stock and $S(\cdot)$ is the installation cost of capital. It takes the form $\frac{1}{\varphi}\left[\frac{I_t^m}{I_{t-1}^m}\right]^{\varphi} I_t^m$, where φ is the investment adjustment cost parameter.

Further, households hold their financial wealth in form of domestic bonds B_t, capital stock K_t and foreign debt B_t^f. Their intertemporal budget constraint is given by:

$$\frac{B_t}{P_t} - \frac{e_t}{P_t} B_t^f + P_{kt} K_t - (1-\delta)K_{t-1} = Y_t - C_t + (1+r_t)\frac{B_{t-1}}{P_t} - \left(1 + r_t^f - \rho_t\right)\frac{e_t}{P_t} B_{t-1}^f -$$

$$Q_t I_t^m - \frac{1}{\varphi}\left[\frac{I_t^m}{I_{t-1}^m}\right]^{\varphi} I_t^m - M_t^l - G_t - Q_t C_{m_t}, \quad (4)$$

where, $Q_t = \frac{e_t P_t^f}{P_t}$ is the real exchange rate, e_t is the nominal exchange rate, r_t is the interest rate on domestic bonds, r_t^f is the interest rate on foreign debt, P_{k_t} is the price of capital, P_t^f is the price of imports, P_t is the price of domestic goods, and ρ_t is the risk premium.

3.2 Firm's and/or Government's Behaviour

Households in this economy supply monopolistically competitive labour. We assume that their labour supply is perfectly inelastic and therefore it does not enter into the production function. We follow Shieh et al. (2002) and d'Agostino et al. (2011) in assuming that output is produced by the government and the private sector. The private sector produces output using private capital stock K_t whilst government produces output using government spending. Government spending is further split into military spending M_t^l and non-military spending G_t. The production function for this economy is therefore given as:

$$Y_t = e^{\xi_{m_t^l}} A_t K_t^{\propto_1} M_t^{l\,\propto_2} G_t^{1-\propto_1-\propto_2} \tag{5}$$

Where, Y_t is the output, A_t is the technological progress, $\propto_1$ is the share of private capital stock in output, $\propto_2$ is the share of military spending in output and $1-\propto_1-\propto_2$ is the share of non-military spending in output.

First Order Conditions

The maximization of the utility function (2) subject to the budget constraint (4) and the production function (5) by choosing a sequence $\{C_t, C_{m_t}, M_t^l, B_t, B_t^f, K_t, I_t^m, G_t\}_{t=0}^{\infty}$ yield the following first order conditions:

$$C_t^{-\sigma} - \lambda_t = 0 \tag{6}$$

$$C_{mt}^{-\theta} - \lambda_t Q_t = 0 \tag{7}$$

$$M_t^{l\,-\omega} + \lambda_t e^{\xi_{m_t^l}} \alpha_2 A_t K_t^{\alpha_1} M_t^{l\,\alpha_2-1} G_t^{1-\alpha_1-\alpha_2} - \lambda_t = 0 \tag{8}$$

$$-\frac{\lambda_t}{P_t}+\frac{\beta E\lambda_{t+1}}{EP_{t+1}}(1+r_t)=0 \tag{9}$$

$$\lambda_t\frac{e_t}{P_t}-\frac{\beta E\lambda_{t+1}e_{t+1}}{EP_{t+1}}\left(1+r_t^f-\rho_t\right)=0 \tag{10}$$

$$-\lambda_t P_{kt}+(1-\delta)\beta E\lambda_{t+1}+\lambda_t\propto_1 e^{\xi_{m_t^l}}A_tK_t^{\propto_1-1}M_t^{l\propto_2}G_t^{1-\propto_1-\propto_2}=0 \tag{11}$$

$$-\lambda_t Q_t-\frac{1+\varphi}{\varphi}\lambda_t\left[\frac{I_t^m}{I_{t-1}^m}\right]^{\varphi}+\beta E\lambda_{t+1}\left[\frac{I_{t+1}^m}{I_t^m}\right]^{\varphi}=0 \tag{12}$$

$$-\lambda_t+\lambda_t(1-\propto_1-\propto_2)e^{\xi_{m_t^l}}A_tK_t^{\propto_1}M_t^{l\propto_2}G_t^{-\propto_1-\propto_2}=0 \tag{13}$$

From equation (8), it follows that $\lambda_{t+1}=C_{t+1}^{-\sigma}$.

Taking first-order Taylor expansion around the steady state, the Euler equations can be re-written as:

$$\tilde{r}_t^f=\tilde{r}_t-E\Delta\tilde{e}_{t+1}+\tilde{\rho}_t \tag{14}$$

$$\tilde{c}_t=\frac{\theta}{\sigma}\tilde{c}_{mt}-\frac{1}{\sigma}\tilde{q}_t \tag{15}$$

$$\tilde{\imath}_t^m=\frac{\varphi}{1+2\varphi}E\tilde{\imath}_{t+1}^m+\frac{1}{1+2\varphi}(r_t-E\pi_{t+1})-\frac{1}{1+2\varphi}\tilde{q}_t+\frac{1+\varphi}{1+2\varphi}\tilde{\imath}_{t-1}^m \tag{16}$$

$$\widetilde{m}_t^l=\frac{\alpha_2}{1+\omega}\tilde{y}_t+\frac{\theta}{1+\omega}\tilde{c}_{m_t}-\frac{1}{1+\omega}\tilde{q}_t \qquad \alpha_2>0\,. \tag{17}$$

Equations 14 to 17 represent the uncovered interest parity condition, consumption based IS, investment function and military spending equation. Note that a tilde on a variable represents deviation from the steady state.

3.3 Equilibrium in the goods market

Per relevant literature, the traditional *gun-butter trade-off* claims that military spending is an unproductive expenditure whilst the *Benoit hypothesis* posits that military spending stimulates growth. In fact, the effect of military spending on economic growth is mixed. Jonakin and Stephens (2004) assert that at relatively low levels of military spending, the supply and demand side effects can generate economic growth; this positive growth would turn negative beyond an inflexion point where

the opportunity costs of military spending rise dramatically. Karagol (2002), Dunne et al. (2004a and 2004b), Yildirim and Sezgin (2002), among others, provide evidence that military expenditure improves economic growth. Conversely, Dunne and Mohammed (1995), Heo (1998), Dunne et al. (2002) and others, show that military spending retards growth. Therefore estimate equilibrium in the goods market, we utilize a simple Keynesian model of the form:

$$y_t = \Omega_1 \tilde{c}_t + \Omega_2 \tilde{\imath}_t^m + \Omega_3 \tilde{m}_t^l + \Omega_4 \tilde{g}_t + \Omega_5 \tilde{x}_t - \Omega_6 \tilde{c}_{m_t} + \xi_{m_t^l} \quad (18)$$

In this equation, government spending is split into military spending and non military spending. Defence spending can either positively contribute to growth or they can deter growth. This is dependent on the parameter Ω_3. If $\Omega_3 > 0$, then the finding will support the *Benoit hypothesis* which posits that military spending stimulates economic growth. However, if $\Omega_3 < 0$, the finding will support the traditional *gun-butter trade-off* which states that military spending deters economic growth.

3.4 Evolution of External Debt

The equation for foreign debt is similar to that of Muhanji and Ojah (2011a) except that we add military spending. Unlike Muhanji and Ojah (2011a) who assume that foreign debt is a balance between exports and imports, we assume that foreign debt is a balance between exports, consumption imports and government spending. We then split government spending into military spending and non-military spending. The attendant foreign debt equation is thus:

$$B_t^f = \left(1 + r_{t-1}^f\right) P_t^f B_{t-1}^{f\vartheta_1} + \left(C_{mt}^{\vartheta_2} - X_t^{\vartheta_3}\right) + e^{\xi_{m_t^l}} M_t^{l\vartheta_4} + G_t^{\vartheta_5}, \quad (19)$$

Log-linearizing Equation 19 around the deterministic steady state gives the following equation for foreign debt.

$$\tilde{b}_t^f = \vartheta_1 r^* \tilde{b}_{t-1}^f + \vartheta_2 \tilde{c}_{mt} - \vartheta_3 \tilde{x}_t + \vartheta_4 \tilde{m}_t^l + \vartheta_5 \tilde{g}_t + \xi_{m_t^l} \quad (20)$$

Equation (20) implies that an increase in military spending, non-military spending and consumption imports lead to an increase in foreign debt whilst an increase in exports leads to a reduction in foreign

debt. We add military spending shock to the debt function. The intuition is that a positive shock to military spending increases indebtedness of the country.

3.5 Price Setting and the Behaviour of Monetary Authorities

To determine inflation, we follow Muhanji and Ojah (2011a) in assuming that firms and workers make both forward and backward looking pricing decisions. The open economy hybrid New Keynesian inflation curve is thus[2]:

$$\tilde{\pi}_t = \kappa\mathbb{Q}\tilde{\pi}_{t-1} + (1 - \kappa\mathbb{Q})\tilde{\pi}_{t+1} + \mathfrak{t}\tilde{y}_t + \mu\tilde{q}_{t-1}, \qquad \mathfrak{t} > 0 \; and \; 0 \leq \mathbb{Q}\kappa \leq 1, \qquad (21)$$

The term $t\tilde{y}_t$ implies that, at any time, there is an upward-sloping relationship between inflation and output gap. The coefficient κ measures the degree of wage indexation to the unexpected changes in prices. Equation (21) differs from the classical Phillips curve because inflation responds not only to fluctuations in output gap but also to fluctuations in the exchange rate. It shows that monetary policy affects inflation through the effects of the lagged exchange rate on the real price of imported inputs.

We also assume that the central bank in this economy does not control the world interest rates, but instead controls the monetary base as in McCallum (1994). Given that the economy is characterized by falls in export prices, tax evasion and civil strife, all of which leaves the government with a large budget deficit, investors do not have confidence that the government will honour its debts. Investors are therefore not willing to buy its bonds and so the Central Bank of this economy finances its current account balance through foreign borrowing and seignorage. However, supply of money in this economy is driven by the output gap and the inflation gap according to Taylor (1993). In closing the model, we assume that money supply evolves according to the following monetary reaction function:

$$\tilde{m}_t = \rho_m\tilde{m}_{t-1} - (1 - \rho_m)\left[\beta_\pi\tilde{\pi}_{t-1} - \beta_y\tilde{y}_{t-1} + \beta_q\tilde{q}_{t-1}\right] - \beta_{\Delta\pi}\Delta\tilde{\pi}_t + \beta_{\Delta y}\Delta\tilde{y}_t + \xi_{mt}, \qquad (22)$$

[2] See Muhanji and Ojah (2011a) for derivation of the inflation function.

where ρ_m is the degree of persistence of monetary smoothing, β_π and β_y represent the sensitivity of money supply to lagged inflation gap and lagged output gap, respectively and ξ_{mt} represents money supply shock. Money supply shock is exogenously determined and follows an AR(1) process of the form $\xi_{mt} = \rho_m \xi_{m_{t-1}} + \xi_{m^*}$ Equation (22) shows that monetary authorities adjust money supply in response to changes in inflation gap and output gap. The monetary rule is that the central bank reduces money supply if inflation exceeds its target value and increases money supply when output falls below capacity.

4. Estimation of the Model

The model is estimated using the Maximum Likelihood method by applying the Kalman filter. The data is first detrended using the Hodrick Prescott Filter (hereafter HP Filter) before estimating the model. Data for the model are downloaded from the World Bank's Global Development Indicators and World Development Indicators (WDI). The data used for military spending are downloaded from WDI even though it is the same data that is provided by the Stockholm International Peace Research Institute. The data covers the period 1970-2010, though for most countries data for military spending covers 1988-2010.

Attempts to estimate the investment function produced very large parameters. These parameters were therefore calibrated. The calibrated and estimated data for the model are presented in Table 1.

Insert Table 1 here

The results show that military spending has a positive and significant effect on GDP for Chad, Ethiopia, Uganda and Sudan (per φ_3 of Eqn. 18). These findings are in agreement with Keynesian economists who argue that higher military spending increases output. Conversely, military spending has a negative but insignificant effect on GDP for Burundi, Congo Democratic and Côte d'Ivoire. Non-military spending positively and significantly contribute to GDP for all countries except Chad and Côte d'Ivoire in which non-military spending has a negative and significant effect on GDP.

Exports positively and significantly contribute to GDP for all countries whilst imports negatively and significantly reduce GDP for all countries except for Chad, Côte d'Ivoire and Sudan. For Chad, consumption imports positively and significantly add to GDP. Except for Chad and Sudan, all the other countries report a positive and significant relationship between imported investments and GDP.

Regarding external debt, the results show that there are mixed findings for the contribution of military spending to external debt. Surprisingly, in Burkina Faso, Central Africa, and Sudan, military spending has a significant negative effect on external debt, suggesting that an increase in military spending reduces external debt in these countries. Burundi, Chad and Mali, military spending significantly increases external debt. The rest of the countries show a positive but insignificant effect of military spending on external debt. The effects of non-military spending on debt also yield mixed results. Non-military spending positively and significantly contribute to debt in Burkina Faso, Burundi and Côte d'Ivoire. It has a negative and significant effect on external debt in Chad, Ethiopia, Uganda and Sudan. Consumption imports and lagged external debt have a positive and significant effect on current debt for most of the sampled countries.

The results for the inflation equation (Eq. 21) show that lagged inflation has a positive and significant effect on current inflation. Most countries have backward looking expectations. Output has a positive effect on inflation for most countries except Burkina Faso, Burundi, Ethiopia and Mali in which output has a negative and significant effect on inflation.

Estimates of the military expenditure equation (i.e., Eqn. 17), show that there is a positive relationship between output and military spending for most countries except Burkina Faso, Burundi and Congo Democratic. Consumption imports also have a positive relationship with military spending for most countries except Burkina Faso, Central Africa, Congo democratic and Mali. The positive correlation between consumption imports and military spending suggests that consumption imports are complementary to military spending in these countries. Further, most countries, except Burkina Faso, Central Africa, Ethiopia and Sudan, record a positive correlation between exchange rate and

military spending. This positive correlation suggests that a depreciation of the exchange rate increases military spending.

5. Shock to Military Spending

To assess the response of pertinent macroeconomic variables to a shock in military spending, we use Uhlig's (1999) method of undetermined coefficients. To solve the linear version of the model, we reduce the solution of the expectational difference equation to the solution of a matrix quadratic equation. The model has five equations with no expectations and two equations with expectations. We therefore solve it using the matrix quadratic equation. We define h_t as a vector of endogenous state variables, f_t as a vector of other endogenous variables (i.e., jump variables) that depend on the values of the state variables and z_t as the vector of the stochastic shock. The state variables naturally follow the ridge but the values of the other variables need to jump to get the system on the stable ridge (see McCandless, 2008; 104 for additional details on this behaviour). Let $h_t = [\tilde{\imath}_t^m, \tilde{\pi}_t]$ denote the vector of endogenous state variables, $f_t = \left[\tilde{c}_{mt}, \tilde{y}_t, \tilde{m}_t, \tilde{m}_t^l, \tilde{b}_t^f\right]$ denote the vector of the jump variables and $z_t = \left[\rho_{m^l}\right]$ denote the stochastic shock. Separating equations that include expectations from those that do not, the linear version of the model can be written as:

$$0 = \mathbf{A}h_t + \mathbf{B}h_{t-1} + \mathbf{C}f_t + \mathbf{D}z_t, \tag{23}$$

$$0 = E_t[\mathbf{F}h_{t+1} + \mathbf{G}h_t + \mathbf{H}h_{t-1} + \mathbf{J}f_{t+1} + \mathbf{K}f_t + \mathbf{L}z_{t+1} + \mathbf{M}z_t], \tag{24}$$

$$z_{t+1} = \mathbf{N}z_t + \varepsilon_{t+1} \qquad E_t(\varepsilon_{t+1}) = 0, \tag{25}$$

where **C** is assumed to be of full rank and has a well-defined inverse and **N** has only stable eigenvalues. We follow McCandless' (2008) method in computing matrices **A** to **N**. We use variables dated $t \; and \; t-1$ in deterministic equations and variables dated $t+1, t \; and \; t-1$ in equations involving expectations $E_t[\cdot]$ (Matrices **A** to **N** can be provided on request).

The solution to this economy is a set of matrices **P, Q, R** and **S**, which describes the recursive equilibrium, and laws of motion so that the equilibrium described by these rules is stable. The equilibrium laws of motion are represented by the following equations:

$$h_t = \mathbf{P}h_{t-1} + \mathbf{Q}z_t, \tag{26}$$

$$f_t = \mathbf{R}h_{t-1} + \mathbf{S}z_t\,. \tag{27}$$

Upon deriving the roots of the quadratic matrix equation, we prepare impulse response functions for a 1% shock to military spending. We simulate the model using 50 time periods. The results are presented in Figure 2.

Insert Figure 2 here

The impulse response functions show that, for all sampled countries, external debt increases after a positive shock to military spending. External debt increases by about 1% for most of the sampled countries. This finding is in line with Karagol (2006) who found that a 1 standard deviation (S.D) shock to military expenditure led to an increase in external debt for Turkey. They are also in line with the empirical findings by Wolde-Rufael (2009) who establish that a 1% increase in defence spending increases the stock of external debt by about 1.5% for Ethiopia. These results suggest that defence expenditures are a determining factor in the indebtedness of Africa's conflict countries. Bearing in mind that the countries under study are arms importers, the total import payments could be financed by external funds. Consequently, external debt liabilities of these countries accumulate over time (Karagol, 2005; Narayan and Narayan, 2008).

Imported investments and output increases after a positive shock to military spending. Apart from Congo Democratic in which imported investments increase by about 2% in response to a positive military spending shock, the rest of the countries report marginal increases in imported investments. For Chad, imported investments do not respond to a positive shock to military spending. The increase in output and investment after a positive military spending appear consistent with Zou's (1995) argument that when foreign military threat rises, a country can react by reducing current consumption and increasing both investment and military spending in the short-run. This leads to both

higher capital stock and higher weapon stock, with the expanding capital stock yielding a growing output. The increase in output after a positive shock to military expenditure is also in line with Karagol's (2006) empirical finding.

Surprisingly, inflation falls after a positive shock to military spending in most of the sampled countries. Money supply also increases after a positive shock to military spending for most countries. The increase in money supply can be supported by the fact that defence spending presses on the total budget. Consequently, countries either finance their budget through seignorage, borrowing abroad or foreign exchange reserves. The net effect is an increase in money supply in the economy.

6. Phases of the Conflict Period and Debt Accumulation

To ascertain which phase of the conflict debt accumulation takes place and/or differentially so, we estimate a bivariate model of military spending and external debt. Initially we separate the data into two periods: pre-war period and combined war and post-war periods, respectively. Pre-war period covers 5 years before the conflict year and post-war period covers the conflict year and post conflict years. The combined periods covers 5 years. The relevant model takes the form:

$$B_t = \kappa_1 M_{it}^l + \varepsilon_t, \qquad i = 1, 2, 3, \dots, N \tag{28}$$

where, ε_t is the error term. Next, we augment Equation 28 with terms of trade (ToT). Recall that exports are generally used to repay external debt and therefore an improvement in ToT reduces external debt. This argument is in line with Muhanji and Ojah's (2011b) finding that exports significantly reduce foreign debt whilst imports increase it for African countries. Thus, the second equation to be estimated takes the form:

$$B_t = \kappa_1 M_{it}^l + \kappa_2 ToT_{it} + \varepsilon_t. \qquad i = 1, 2, 3, \dots, N \tag{29}$$

To estimate Equations 28 and 29, we use the fixed effects panel data regression method. This choice is informed by the unbalanced nature of our panel data where the random effects method

would produce biased estimates. The results for the two pertinent equations are presented in Table 2. Model 1 shows the results for Eqn. 28 and Model 2 shows results for Eqn. 29.

Insert Table 2 here

The results for model 1 show that an increase in military spending leads to an increase in external debt during pre-war, war and post-war periods for Africa's conflict countries. Specifically, during the pre-war period, a 1% increase in military spending leads to a 0.60% increase in external debt; and during war post-war periods it leads to increases in external debt of 0.51% and 0.72%, respectively. The magnitude of the increase in debt during post-war period is the highest, which suggests that countries borrow more externally to fund military expenditure post the conflict proper. There is therefore either a tendency of circumspection around avoiding perceived vulnerability or the tendency of benefiting arms merchants (largely government officials) in an attempt to entrench their vested interest. The policy upshot is that either of these possibilities must be checked if government is to avoid inadvertent external debt over-run.

Results for Model 2 show that ToT insignificantly reduce external debt during the three conflict periods. Inclusion of ToT in the model yields a negative but insignificant coefficient for military spending during the war period but the positive effect of military spending on external debt during pre- and post-war periods remains robust to the inclusion of ToT. In fact, the result of Model 2 reinforces the finding that, on average, military expenditure runs up the external debt the most during post-conflict periods. Specifically, a 1% increase in military spending during pre-war and post-war periods lead to increases in external debt by about 0.30% and 0.79%, respectively. The increase in debt during post-war period is almost twice the increase during pre-war period[3].

7. Conclusion

[3] Note that given the smallness of our sample, our results should be interpreted with care. Further, the bivariate model may leave out some important variables that can lead to indebtedness of these countries, as evidenced in results of the structural model in section 3.

Using DSGE model, impulse response functions and panel analysis, we investigate the relationship between military spending and external debt in Africa's conflict countries. We find that a correlation exists between military spending and the external debt of most of these countries. An impulse response analysis shows that a positive shock to military spending leads to an increase in the external debt of all sample countries. Importantly, we also document that military spending leads to a significant increase in external debt during all phases of the conflict period – pre-war, war and post-war periods, with the most debt accumulation occurring during the post-conflict period. Overall, these results suggest that military spending can be considered, in a nuanced way, as an important factor in designing debt management policies for Africa's conflict countries and their likes.

References

Alami, R. (2002). Military debt: Perspectives from the experience of Arab countries. *Defence and Peace Economics*, 13(1), 13-30.

Benoit, E. (1973). Defence and economic growth in developing countries. Lexington Books, Lexington.

Benoit, E. (1978). Growth and defence in developing countries. *Economic Development and Cultural Change,* 26(2), 271-280.

Brzoska, M. (1983). The military related external debt of Third World countries. *Journal of Peace Research*, 20(3), 271-277.

d'Agostino, G., Dunne, J. P. and Pieroni, L. (2011). Optimal military spending in the US: A time series analysis. *Economic Modelling,* 28, 1068-1077.

Dunne, J. P., Perlo-Freeman, S. and Soydan, A. (2004a). Military expenditure and debt in small-industrialised economies: A Panel Analysis. *Defence and Peace Economics*, 15(2), 125-132.

Dunne, J. P., Perlo-Freeman, S. and Soydan, A. (2004b). Military expenditure and debt in South America. *Defence and Peace Economics*, 15(2), 173-187.

Dunne, J. P., Smith, R. P. and Willenbockel, D. (2005). Models of military expenditure and growth: A critical review. *Defence and Peace Economics,* 16(6), 449-461.

Georgantopoulos, A. G. and Tsamis, D. (2011). The interrelationship between military expenditure and external debt: Patterns and causation in Northern Africa countries. *Journal of Economics and Behavioural Studies,* 3(4), 264-273.

Gong, L. and Zou, H. (2003). Military spending and stochastic growth. *Journal of Economic Dynamics and Control,* 28, 153-170.

Günlük-Senesen, G. (2004a). Special issue on deficits, debt and defence. *Defence and Peace Economics*, 15(2), 109-110.

Günlük-Senesen, G. (2004b). The role of defence on external indebtedness: An assessment of Turkey. *Defence and Peace Economics*, 15(2), 145-156.

Hodrick, R. J. and Prescott, E. C., (1997). Postwar U.S. business cycles: an empirical investigation. *Journal of Money, Credit and Banking* 29, 1–16.

Karagol, E. T. and Turhan, A. (2008). External debt, defence expenditures and political business cycles in Turkey. *Defence and Peace Economics*, 19(3), 217-224.

Karagol, E. (2005). Defence expenditures and external debt in Turkey. *Defence and Peace Economics*, 16(2), 117-125.

Karagol, E. (2006). The relationship between external debt, defence expenditures and GNP revisited: The case of Turkey. *Defence and Peace Economics*, 17(1), 47-57.

Looney, R. E. (1989). The influence of arms imports on third world debt. *Journal of Developing Area,* 23(2), 221-231.

Looney, R. E. (1990). The role of military expenditures in the African economic crisis. *The Jerusalem Journal of International Relations,* 12(1), 76-101.

Looney, R. E. and Frederiksen, P. C. (1986). Defence expenditures, external public debt and growth in developing countries. *Journal of Peace Research,* 23(4), 329-338.

McCallum, B. T. (1994). Monetary policy and the term structure of interest rates". NBER *Working Paper* No. 4938.

McCandless, G. (2008). *The ABCs of RBCs: an introduction to dynamic macroeconomic models*. Harvard University Press, Cambridge, Massachusetts.

Muhanji, S. and Ojah, K. (2011a). External shocks and persistent external debt in open vulnerable economies: the case of Africa. *Economic Modelling* 28, 1615–1628.

Muhanji, S. and Ojah, K. (2011b). Management and sustainability of external debt: the case of Africa. *Review of Development Finance1*, 184–206.

Narayan, P. K. and Narayan, S. (2008). Does military expenditure determine Fiji's exploding debt levels? *Defence and Peace Economics*, 19(1), 77-87.

Narayan, P. K. and Smyth, R. (2009). The military expenditure-external debt nexus, new evidence from a panel of Middle Eastern countries. *Journal of Peace Research,* 46(2), 235-250.

Sezgin, S. (2004). An empirical note on external debt and defence expenditures in Turkey. *Defence and Peace Economics*, 15(2), 199-203.

Shieh, J., Lai, C. and Chang, W. (2002). The impact of military burden on long-run growth and welfare. *Journal of Development Economics,* 68, 443-454.

Taylor, J. B. (1993). Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy* 39, 195–214.

Uhlig, H., 1999. A toolkit for analyzing nonlinear dynamic stochastic models easily. http://www2.wiwi.hu-berlin.de/institute/wpol/html/toolkit/toolkit.pdf.

Wolde-Rufael, Y. (2009). The defence spending-external debt nexus in Ethiopia. *Defence and Peace Economics*, 20(5), 423-436.

Zou, H. (1995). A dynamic model of capital and arms accumulation. *Journal of Economic Dynamics and Control,* 19, 371-393.

PWT 7.0 Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 7.0, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, May 2011.

Table 1: Estimated and Calibrated Parameters

Estimated Parameters	Burkina Faso	Burundi	Central Africa	Chad	Congo Democratic	Côte d'Ivoire	Ethiopia	Mali	Uganda	Sudan
θ	0.3984 (0.3560)	0.0826 (2.4890)**	-0.0133 (-0.9660)	0.1403 (0.1587)	1.6099 (0.7081)	0.0147 (1.5374)	0.3644 (1.0388)	-0.8591 (-3.5289)***	0.7305 (8.6664)***	-0.0020 (-0.6188)
σ	-0.7798 (-9.1462)***	0.2104 (2.5309)**	-0.0861 (-1.4511)	0.2465 (6.1626)***	-1.4530 (-7.0885)***	0.0525 (1.4305)	1.6092 (5.1893)***	-0.1050 (-1.6619)*	-0.0359 (-0.9744)	-0.0228 (-0.7453)
ω	-5.6722 (-1.7918)*	0.6793 (2.1779)**	-0.1572 (-2.9187)***	0.7329 (0.2216)	-2.8314 (-1.7351)*	-0.2945 (-3.4849)***	1.9211 (1.7805)*	1.0927 (2.2133)**	-0.0898 (-2.3332)**	-5.5570 (-3.1884)***
α_2	0.01 [c]	-0.2396 (-1.1330)	0.1918 (0.5653)	0.03[c]	0.02[c]	0.6321 (1.4772)	0.6925 (0.5147)	1.2325 (2.1646)**	0.0967 (0.5226)	-3.1252 (-1.4147)
ϑ_1	-0.1091 (-0.3024)	0.6769 (4.7607)***	0.3669 (1.4888)	0.1406 (4.8715)***	0.8651 (7.0328)***	0.0389 (0.2381)	0.3495 (1.9053)*	0.8597 (8.0660)***	0.7088 (9.6362)***	0.3080 (2.3961)**
ϑ_2	2.4722 (2.9589)***	0.0038 (0.0292)	0.2259 (0.6592)	0.1027 (7.3922)***	1.2543 (5.2767)***	0.1893 (0.6508)	0.4803 (0.8440)	0.1102 (0.3966)	1.6758 (7.9487)***	1.0642 (3.4267)***
ϑ_3	-1.6021 (-3.0141)***	0.1822 (1.5248)	-0.6413 (-2.2325)**	0.0527 (6.5457)***	-1.3219 (-3.7091)***	0.4592 (1.7143)*	0.1913 (0.4277)	-0.0169 (-0.0851)	-0.0074 (-0.0595)	1.2564 (4.4786)***
ϑ_4	-0.9572 (-1.9837)**	0.3893 (1.9317)*	-1.7297 (-4.6807)***	0.0667 (7.2739)***	0.0126 (0.4223)	0.0436 (0.5162)	-0.1772 (-1.3999)	1.2204 (3.8725)***	0.1513 (0.6509)	-0.5956 (-4.1441)***
ϑ_5	3.3668 (2.3926)**	0.1228 (1.7266)*	0.0715 (0.7640)	-0.3276 (-6.5116)***	0.2164 (1.2376)	0.3687 (2.2035)**	-0.4499 (-1.8658)*	0.0955 (1.1739)	-0.9222 (-4.6793)***	-0.8528 (-4.4674)***
ϱ_1	0.6070 (8.1218)***	0.9227 (4.0815)***	0.8013 (9.8273)***	-0.1764 (-1.2214)	0.6813 (2.6850)***	0.5650 (3.3165)***	0.7837 (21.8976)***	0.8599 (8.6045)***	0.7489 (10.8004)***	0.8153 (8.7862)***
ϱ_2	0.2055 (4.7136)***	0.1092 (4.3254)***	0.0989 (12.7281)***	-0.1120 (-2.2698)**	0.1049 (3.8907)***	0.1038 (2.8268)***	0.1862 (8.4796)***	0.2348 (2.4851)**	0.1310 (2.0581)**	0.0241 (0.5004)
ϱ_3	0.0397 (1.1504)	-0.0196 (-0.1933)	0.0470 (1.2562)	0.0878 (5.0612)***	-0.0038 (-0.7109)	-0.0474 (-1.2797)	0.0338 (4.9543)***	0.0046 (0.0833)	0.1071 (2.5884)**	0.0512 (2.0544)**
ϱ_4	0.2159 (2.2089)**	0.1103 (3.5481)***	0.0530 (7.1872)***	-0.3003 (-2.2045)**	0.1704 (1.7915)*	-0.1596 (-2.5291)**	0.0842 (7.9324)***	0.0651 (2.1909)**	0.1510 (4.7691)***	0.0830 (2.4926)**
ϱ_5	0.1001 (2.4401)**	0.1066 (3.0690)***	0.1323 (5.5400)***	0.2937 (9.1772)***	0.3777 (8.4896)***	0.2457 (2.7922)***	0.0425 (1.9531)*	0.1905 (2.2220)**	0.2101 (9.8038)***	0.0842 (2.4287)**

The symbol [c] represents calibrated parameter. These are parameters that could not be estimated because they produced values that were too large. They were calibrated by taking the average value of the variable. The values in parenthesis are the Z- Values. The symbol ***, ** and * represent significant levels at 1%, 5% and 10%, respectively.

Continuation Table 1: Estimated and Calibrated Parameters

Estimated Parameters	Burkina Faso	Burundi	Central Africa	Chad	Congo Democratic	Côte d'Ivoire	Ethiopia	Mali	Uganda	Sudan
ϱ_6	-0.1825 (-3.5445)***	-0.2541 (-2.2921)**	-0.1352 (-4.1535)***	0.3075 (2.7117)***	-0.3010 (-4.0923)***	-0.0974 (-0.6982)	-0.1330 (-6.4313)***	-0.3528 (-2.1646)**	-0.2002 (-3.3155)***	-0.0358 (-0.7419)
κ	0.4420 (5.0266)***	0.5330 (4.8263)***	0.3179 (1.7266)*	0.5148 (4.2855)***	0.7768 (8.2450)***	0.4105 (5.4255)***	0.6155 (3.8486)***	0.6208 (3.5658)***	0.5160 (5.0328)***	0.5290 (6.3304)***
$\mathfrak{t}$	-16.4566 (-2.0472)**	-3.1674 (-1.9315)*	7.8786 (1.8674)*	-3.3324 (-0.7180)	0.6650 (0.6804)	0.4096) (0.3138)	-9.3553 (-2.8461)***	-18.2334 (-1.7163)*	-1.2423 (-1.2954)	-0.5394 (-0.9766)
μ	-0.2195 (-0.1477)	0.0670 (0.0507)	2.5288 (1.2161)	-3.9592 (-1.0702)	-0.3427 (-4.0200)***	-0.6917 (-1.2176)	1.0113 (0.5118)	1.4849 (0.4713)	-0.0187 (-0.0600)	-0.1420 (-0.7543)
ρ_m	0.4697 (3.4935)***	0.0727 (0.2939)	0.1594 (1.5573)	0.3544 (2.1001)**	0.0588 (0.9133)	0.5611 (2.6391)**	0.6499 (2.3018)**	-0.0261 (-0.0581)	0.5739 (4.0169)***	0.5797 (3.4929)***
β_π	0.0208 (0.8374)	-0.0616 (-1.3997)	0.0256 (3.1905)***	-0.0242 (-3.0558)***	0.0109 (0.3078)	0.0126 (0.2552)	-0.0537 (-2.4267)**	-0.0116 (-0.6386)	-0.0618 (-1.1580)	-0.0751 (-2.8630)***
β_y	-0.6921 (-0.9532)	1.3865 (6.5876)***	-0.5718 (-1.3225)	0.7638 (2.0160)**	1.0678 (3.2931)***	1.1710 (3.1931)***	0.1072 (0.3636)	2.9069 (4.1787)***	1.2186 (2.1154)**	0.1168 (0.4398)
β_q	-0.1647 (-2.9729)***	0.0214 (0.1165)	0.0293 (0.2328)	0.0338 (0.1202)	-0.0915 (-1.9157)*	-0.0170 (-0.0785)	-0.0515 (-0.4498)	0.2067 (0.9404)	-0.0592 (-0.3178)	-0.0795 (-1.7646)*
$\beta_{\Delta\pi}$	0.0128 (0.1667)	-0.0053 (-0.1683)	0.0253 (3.6256)***	-0.0205 (-5.0620)***	-0.0016 (-0.0555)	0.0055 (0.3597)	-0.0468 (-3.1706)***	-0.0060 (-0.4443)	-0.0038 (-0.4678)	-0.0155 (-0.4133)
$\beta_{\Delta y}$	0.7292 (2.5506)**	0.9035 (2.7001)***	-0.0032 (-0.0114)	0.0820 (0.6345)	0.2404 (0.6466)	1.2065 (4.2000)***	0.0028 (0.0096)	1.9448 (2.3698)**	0.4895 (2.4353)**	0.4970 (3.4351)***
Calibrated Parameter										
φ	3	3	3	3	3	3	3	3	3	3

The symbol [c] represents calibrated parameter. These are parameters that could not be estimated because they produced parameters that were too large. They were calibrated by taking the average value of the variable. The values in parenthesis are the Z- Values. The symbol ***, ** and * represent significant levels at 1%, 5% and 10%, respectively.

Table 2: Military Spending and External Debt during Pre-war, War and Post-war periods

Variables	Model 1			Model 2		
	Pre-War	War	Post-War	Pre-War	War	Post-war
Intercept	5.0512	5.6952	3.8222	7.4754	10.3592	3.2972
	(4.60)***	(8.92)***	(1.44)	(5.15)***	(16.20)***	(1.24)
Lrmilexp	0.5963	0.5153	0.7185	0.3091	-0.0169	0.7932
	(4.44)***	(6.91)***	(2.35)**	(1.74)*	(-0.23)	(2.57)**
ToT				-0.0180	-0.0428	-0.0940
				(-0.21)	(-0.51)	(-1.31)
Observations	28	69	45	25	58	45
Hausman Test						

Model 1 shows results for external debt and military spending during pre-war, war and post-war periods. Model 2 shows results for external debt, military spending and terms of trade during pre-war, war and post-war period.

Figure 1: Military Spending/GDP and External Debt/GDP for Selected African Conflict Countries

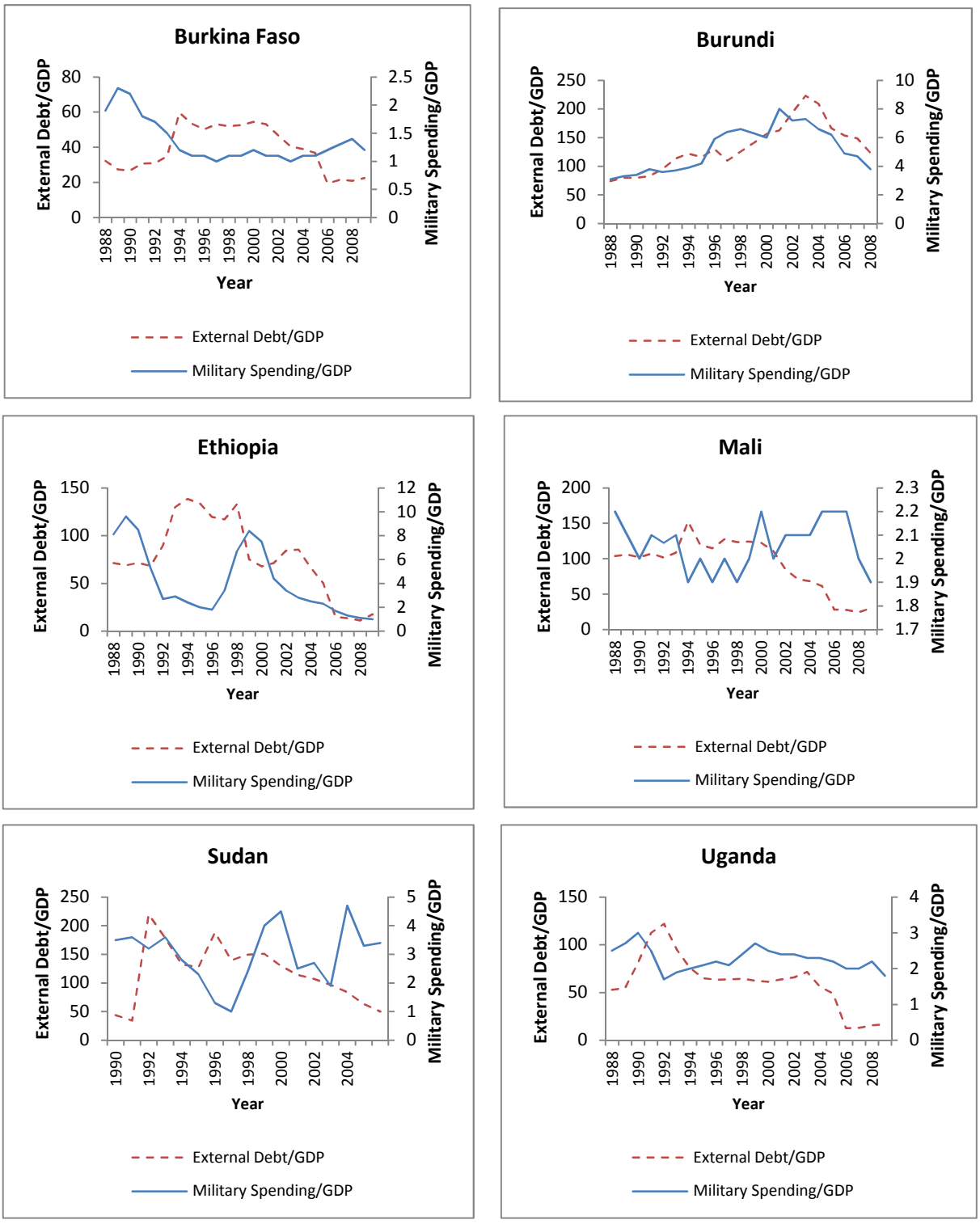

Figure 1: Continuation

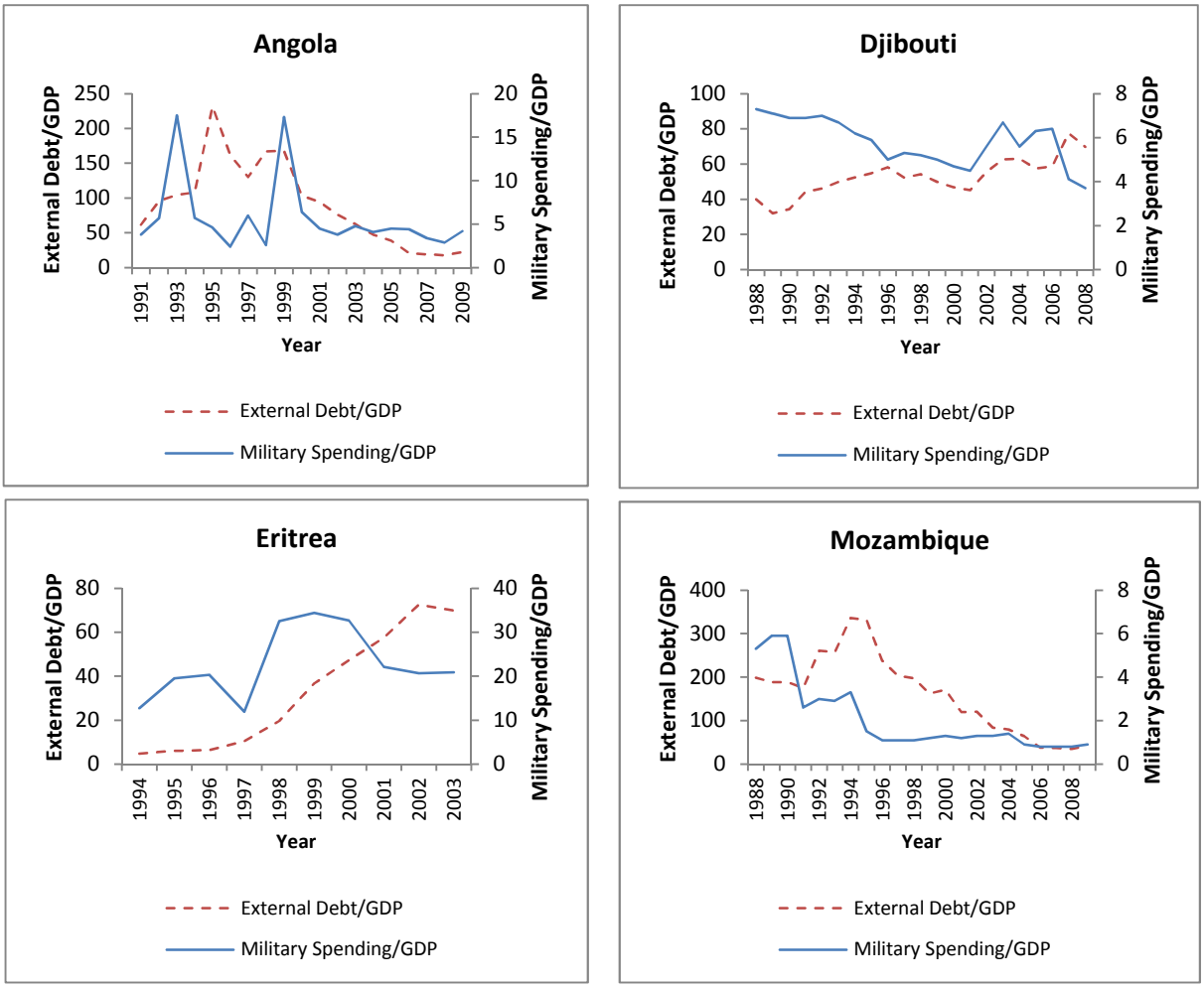

Figure 2: Persistent Shock to Military Spending

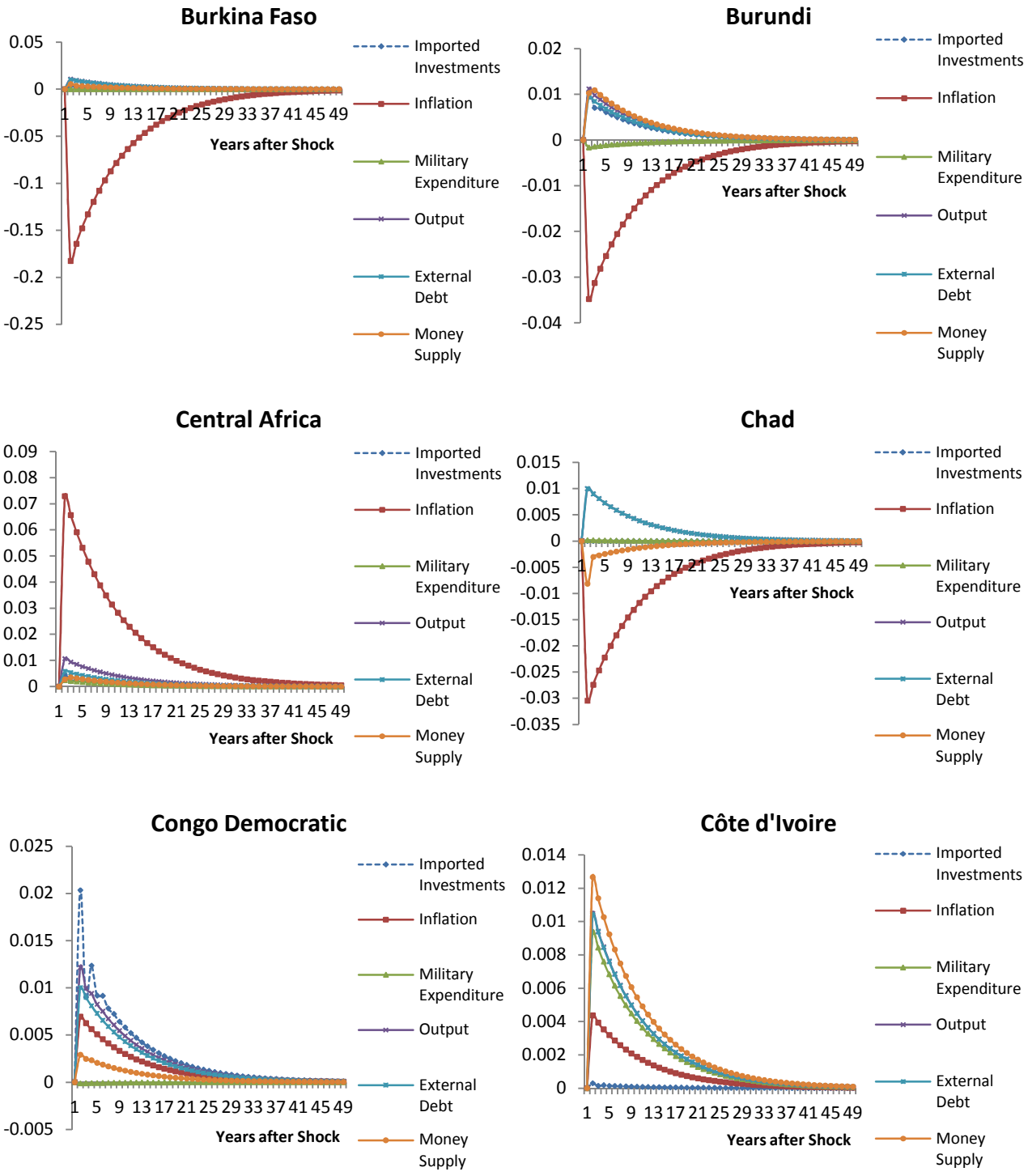

Figure 2: Persistent Shock to Military Spending